SCALE INSECTS ON DECIDUOUS

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CHAPIN

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BY

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A REPORT TO THE STATE BOARD OF HORTICULTURAL COMMISSIONERS.

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Scale Insects on Deciduous and Ornamental Trees

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A Report to the State Board of Horticultural Commissioners.

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The prevalence of scale insects in the orchards of Santa Clara valley during the past few years has afforded ample scope for their study, to which I have, for the past three seasons, devoted what time I could command. Assigned to this work by you, I shall report so concisely as possible the information gained and the results obtained by numerous experiments carried on and observed for two seasons. I shall here use in this paper as a part of it, a report presented to the Santa Clara County Horticultural Society August 6, 1891, by Mr. D. C. Vestal and myself, with such revisions and corrections as another year has shown to be needed, and with added memoranda on the experiments detailed, in order to present their full effects after a lapse of more than a year. I shall also detail other experiments, and shall refer to work done on an extensive scale for the destruction of the scale pests, and which has shown such gratifying results.

All scale insects injure, to a greater or less degree, the vitality and productiveness of the tree or plant upon which they live. Of the seven species which have here been observed as infesting our deciduous orchard trees and fruits, five are of frequency and of such importance as to attract the attention of orchardists. These are the *Lecanium Olew*, *Aspidiotus Aspidis*, *Aspidiotus Conchiformis*, *Aspidiotus Forbesi nova* and the *Isarya Purchasi*, the two last named being the most dangerous of all scale pests which the entomologist has to encounter.

Lecanium Olew.—This scale in beginning to attack other trees than the orange and its kindred A year ago I examined an orchard where it existed in overwhelming numbers upon the German prune, Begg's Red May and the Early Crawford peaches upon the Moorpark apricot trees and most of all upon the *Petite prune d'ages* trees. This is believed to be the direct result of planting a few orange trees close by. Mr. Elwood Cooper has referred fully upon this scale, and to whose reports I refer you

Aspidiotus Aspidis.—So named by Prof J. H. Comstock. This scale is rapidly spreading and is now found in many places where only two or three years ago it seems to be most prominent in Santa Cruz county, where it can be abundantly found. I have, during the past two seasons, observed it in many places in Santa Clara county, and have and specimens sent me from San Lorenzo, Alameda county, where it was abundant upon pear trees, a branch sent being well covered with the old scale and also newly hatched young crowling about.

This scale seems to be native to the willow and alder and other indigenous trees. It, however, is found in great numbers upon acacia trees, upon the black locust and poplar, and upon some of our orchard trees as the pear and apple. This scale somewhat resembles the *Aspidiotus perniciosus*, and by many is confounded with it, but it is not to be compared to the latter for destructiveness.

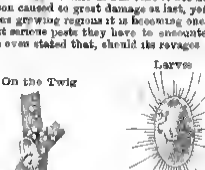
Aspidiotus Conchiformis.—The one longest known, and which was discovered and described to Mance in 1758, has ever since that time infested the apple tree particularly, although found upon other fruit trees and upon the currant. This is now found in great numbers upon almost all old apple trees on this coast, and is commonly known as the bark louse or the oyster shell scale. It may be found described in works on entomology. This species has not caused so much injury as to alarm fruit growers to any great extent, although it is determined by Dr Packard as doing more injury to the apple tree than any other insect known.

Cottony Cushion Scale.

Next will be described a comparatively new scale here-to-fore, but one which has within the last two or three years been ravaging many localities to widely different parts of the State. This is the so called dorthesia, or, as named by Maskell, *Isarya Purchasi*, and called by Mr. Matthew Cooke the cothony cushion scale.

This scale has been, it is asserted, known to be on the acacia for seven years in San Jose, but it is only during the pier and present seasons that it has attracted attention. Its great prolificness and its destructive abilities have called widespread attention to it. This pest attacks everything in the way of tree, vine or shrub, all the evergreens as well as deciduous trees and plants in its way are attacked, and every orna-

dental shrub on the lawns of some portion of our cities will show its presence. The ivy even, is not proof against it. In San Rafael, San Mateo, Santa Barbara and Los Angeles it is well established. While in San Jose it has not this season caused so great damage as last, yet in the citrus growing regions it is becoming one of the most serious pests they have to encounter, and it is even stated that, should its ravages not be



Cottony Cushion Scale—Icerya Purchasi

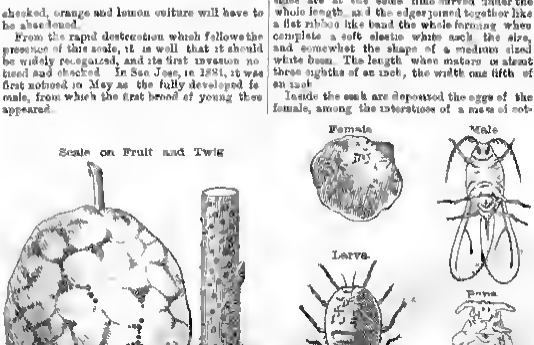
checked, orange and lemon culture will have to be abandoned.

From the rapid destruction which follows the presence of this scale, it is well that it should be widely recognized, and its first invasion noticed and checked. In San Jose, in 1881, it was first noticed in May as the fully developed female, from which the first brood of young then appeared.

haps the twenty fifth of an inch in length. The body is pale red, the six legs and two antennæ are black. The antennæ are long and club-shaped, and have from six to nine joints, as they are further matured, the antennæ are covered with long hairs, which bristle forth prominently. The eyes are small and black. Between the pair of forelegs on the under side of the body is to be seen the beak or sucker, by which the insect secures its nourishment.

The females partly grown are of a variety of colors, orange red mostly, and specimens cover with white and green, some are nearly entirely a dirty white, and many are a pea green. It seems that the coloring matter of the plant they are upon colors them to some extent. Their body is ovoid and elongated and flattened, the back being ridged up with several segments quite prominent. Around the rim of the body are a multitude of hairs standing out prominently. Around the rear half of the body on its rim are a row of tubercles or spinerets, from which a white secretion issues, forming a cottony cord, and these placed side by side and the interspace filled up by the same material running lengthwise the body and projecting from it, gives the whole a ribbed, satin like appearance whitish in color. Gradually as the insect matures these projecting ridges approach each other at the ends, and are joined together and curved under slightly at the point, while the sides are at the same time curved under the whole length, and the edges joined together like a flat ribbon like band the whole forming when complete a soft cloche white sack the size, and somewhat the shape of a medium sized white bean. The length when mature is about three eighths of an inch, the width one fifth of an inch.

Inside the sack are deposited the eggs of the female, among the interstices of a mass of cot-



SAN JOSE SCALE INSECT—Aspidiotus Perniciosus.

This present season of 1882 the first young appeared May 26th, the mother insect having gradually matured her eggs from the opening of spring until the young were hatched. The egg of the *Icerya* is small, pale or orange red, elongated and oval. The young just hatched out are very active, and are very minute, per-

tol like fiber, which under a high magnifying power is shown to be round, and not more than one sixth part the thickness of pure cotton fiber, with which it was conspicuously in the same field. This mass of cottony fiber is filled with a great amount of granular matter, for the purpose, it may be, of affording sustenance to

the young insects within the sack. The young hatch out in this sack, and make their way out into the world through a rent in the soft and tender underside of the sack.

The female, after finding her home and during maturity, does not move although she does not lose her legs, but clings tenaciously with her feet to her support leaving the body tipped up in the rear and the oblong mass noticable in any direction. The male insect was only found during a period of about two weeks from Sept.

BLACK SCALE—Lecanium Olea.

28th. This was the observation of 1881, when I found them in great numbers. I have failed to find the *lotus* insect this season. It has a long red body, six legs and one pair of very long, dark and transparent wings, prominent eyes and antennæ very long and covered with hairs, arranged very much as the feathers of a peacock.

The antennæ are 16 or 17 jointed. The winged male is easily seen and easily caught, as it moves slowly about, and is not readily disturbed so as to fly away. The female insect lives upon the trunk of the tree and large grown and with the young hatched out and crawling in the same sack. In 1881 they rapidly increased from about the first of August, and were continually appearing, and still hatching out in December.

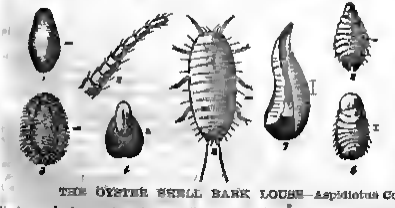
Every female, it is estimated, produces from 200 to 300 young. The young will mature and produce a new brood in about three months. Where this scale infests deciduous trees it may be readily destroyed by the applications now found to be successful in treating the *Aspi-*

diotus Perniciosus, and detailed further on in this report.

Where, however, evergreens are involved it is a far more serious problem. The best treatment for the *Icerya*, so far found, is that used by Mr. Cooper, of a strong and hot infusion of tobacco, applied by spray as near as may be at 150°.

Aspidiotus Perniciosus.

By far the most injurious scale pest infesting our orchard trees and fruit is the new species of *Aspidiotus*, which, so far as known, originated



THE OYSTER SHELL BARK LOUSE—Aspidiotus Conchiformis.

limbs and down to the smallest twigs, around which it may be seen clinging in clusters sufficiently great to completely hide the branch also upon the leaf along the stem and ribs of which it is fixed, both above and below, although more abundant on the underside of the leaf.

There are three broods of this insect in the season; the first appearing in May the second in August and the third in October, or about three months apart. I have just observed, October 17th, the mature female with eggs fully

to San Jose, and for some years was confined to this locality. It has been known as the San Jose small, round, black scale and named by Prof. Comstock *Aspidiotus pernicosus*. The spread of this scale over the State has been gradually taking place, until now it can be found in a number of the fruit-growing counties, notably San Joaquin, El Dorado, Nevada, Placer, Sacramento, Yolo, Solano, Sonoma, Alameda, Santa Cruz, San Benito and others, and I am told even to Humboldt in the north and in the southern counties. This scale produces ter-

cible results in an orchard when once established Its ravages have caused widespread alarm, and unless checked soon causes entire destruction of the trees infested The trees become entirely covered with the scale, so that no portion of the bark can be seen The fruit also becomes covered in the same manner and is rendered unfit for use. The losses caused by the ravages of this one pest cannot be easily computed Whole orchards are literally destroyed by it In many cases those who have recognized its presence and destructive power in time have made most strenuous efforts to stay its spread and save their trees, but it has hitherto been to a great degree, discouraging owing to the difficulties encountered in fighting an unknown foe Within the past two years, however, great progress has been made in destroying this insect, and it is now considered certain that we have an efficient means of ridding ourselves of one of the most dangerous pests known to fruit growers

The trees attacked embrace every kind of deciduous fruit trees except the Black Tartarian cherry, and it is supposed two or three other black cherries. Some varieties are less liable than others to its attacks, but we have found it upon all other trees than those excepted above.

Poplar and other ornamental and shade trees give it a support It infests hedges of Osage orange and the wild cherry, many of which have been destroyed in the past two years, and have been dug out. It is found on the currant, and quickly destroys the bush. It has been found upon rhubarb and tomato plants growing in orchards among infested trees This scale evidently prefers some varieties of trees, but yet, when placed upon others not so well liked, will stay and colonize to some extent

The effect of this scale insect upon the tree is peculiar After a short residence there, the green layer of the bark becomes stained a very dark red color, which continues until the death of the limb or tree unless the insect be killed The bark may then be restored to its normal color and health.

A Financial Aspect

The damage in Santa Clara county has already become so great as to cause the most serious losses not alone to the fruit growers but also to the public at large—and from the orchards affected has greatly lessened the revenue which has been derived from the production and sale of fruit One instance stated definitely will suffice to show these losses.

This orchardist states (1881) that he has 2 000 trees badly infested with scale, 1,000 of these trees are totally destroyed, and will be dug out this season, the balance are badly injured, but can probably be saved This portion of his orchard in health returned at least $8,000 per year His loss on crop from these trees in 1880 was over $2,000 For 1881 there was a total loss of crop on 1 500 trees. This orchard has regularly paid an interest of 10% on $1,000 per acre The scale pest alone has cost a loss of $20,000 to the owners.

Further on reference will again be made to this orchard The Assessor's roll for 1881 reports in this county 335 537 bearing trees of the apple, pear, plum and peach. This does not include the large number of trees which have been destroyed and are unfruitful neither the immense number of young trees that have been planted, but not yet paying and, as observed, it leaves out the large number of other varieties, cherries almonds, apricots etc, in bearing, which, it is estimated, would make a grand total of 1 000 000 trees Should the losses experienced by the orchardists now suffering be carried out in all, you can readily estimate the astounding result. The value of the Santa Clara county fruit crop for 1880 was returned at $976 475, notwithstanding the immense losses incurred. The sworn statement of the Assessor, now before me, says "That all fruit trees in Santa Clara county are assessed as improvements at the following prices Trees in full bearing, free from scale, $1 50 per tree, trees bearing affected with scale, from 00 to 50 cts. per tree, and that there is a large number of orchards situated east and northeast from the city of San Jose, badly infested with scale (and after naming some says), and in consequence are assessed at 00 to 50 cts. per tree " From this it will be seen that the revenue derived from taxation is seriously affected by the presence of this pest upon our orchard trees

The Assessor's roll for 1882 gives of the four varieties of trees named above—apples, peaches, pears and plums—bearing trees subject to tax alone 280 347, a deduction from the previous year's assessment of 55,190 trees. This loss is in fact upon apple, plum and peach trees, as the young pear trees coming into bearing and being assessed for the first time, more than equal the loss on that variety So it is seen that the loss in assessed value on these three kinds of trees totally destroyed has amounted in the one year to $82 785 This is actually but a small part of the loss, as other varieties of trees destroyed, and the losses of previous years from the scale as well as the reduced value of trees affected but still bearing, cannot well be enumerated These trees were destroyed before the application of proper remedies, now, however, from the knowledge of correct treatment these losses will soon cease, and the taxable property of the county be immensely increased I feel assured that the next assessment will show a decided improvement. Thus the magnitude of this evil becomes apparent, and the problem to be solved is of vast importance.

Description of this Pest

From the study we have given to this scale during the past three years it may be briefly described as follows The scale insect is massed upon the bark of the tree and fruit as well, the scale of a dark grey or blackish and rough exterior which covers the insect being very small and round in shape over the female, while that covering the male is much smaller and elongated on one side. In both, the higher and central portion of the scale has a yellowish color and directly under which may be found the insect itself, which is soft and delicate in structure and of a pale straw color. There is no connection between the cover and the insect, which is merely protected by it from harm The shell-like scale is formed by either the cast-off skins of the larva or by a waxy secretion of the body of the insect. The microscope shows the young female insect oval in shape and flattened At

first it is very small and hardly perceptible to the naked eye, but careful observation will detect it as a minute yellow dot on the bark of the tree, crawling about with the six legs with which it is provided, and seeking a favorable locality upon which to fix itself for life. It will crawl about for only a day or two, and then fastens itself to the bark by a beak like protuberance which it inserts, and procures our ishment from juices of the tree. Immediately upon fixing itself it begins to be covered with a silvery material, which, as it grows older, is gradually changed in color to a very dark hue and enlarges to the size of about one-sixteenth of an inch in diameter. The insect soon after fixing itself loses its legs and antennæ and thus remains through life, keeping its flattened shape but growing wrinkled and almost round, gradually increasing in size to perhaps one-sixteenth of an inch in width and one fifteenth of an inch in length when full of young. After the young emerge it is dried up and disappears. We have counted from the female, when full of young, between 50 and 60 of the minute sacks which contain the young perfectly formed insects ready to crawl about. The young male insect is produced in the same manner and at the same time, though not in such numbers; perhaps half a dozen males to a hundred females. In size the male is about one third that of the female, and in shape very different, being elongated and more angular, provided with six legs placed differently upon the body, with two antennæ and two eyes, and with a beak like protuberance at the rear end of the body ending with a point.

At this stage of its existence the male has no wings, and it cannot be discerned without the aid of a magnifying glass. The color of the young male is not a yellow, but of a steel like or whitish hue. It crawls about and fixes itself upon the bark, as does the young female, and becomes covered with a scale in the same manner, but which is elongated upon one side, and not more than one half the size of the scale of the female. The male, after remaining its allotted time in the pupa state, emerges as a fully developed insect having eyes, antennæ, six legs and one pair of very long wings of a reddish and transparent appearance, and the protuberance at the rear end of the body is developed into a very long tapering point, nearly as long as the body itself. The perfect winged male is so minute it can with great difficulty be discerned by the naked eye, crawling and flying about in search of the female, which it impregnates under the scale and then having fulfilled its mission, it dies.

In the season of 1880 we saw the winged males first appear on March 23d, and in great numbers for a few days. The first brood of young scales appeared the latter part of April. On June 27th we found the males from the first brood under the scales and nearly developed with appendages and wing pads, and on July 2d large numbers of them flying about, also as late as July 23th, and still later, on August 2d, a few were seen. On July 22d the trees were covered with the young of the second brood, August 2d the young males of the second brood were found crawling about. Bark scraped clean on the 22d of July was found on the 25th alive with young insects, and some of these already commencing to be covered with scale. As it was expected at the time these observations were made, a third brood would appear about October, so we found it. On October 17th we found the male scale insect in the first pupa stage of development in the winged form, and also on the same day found the perfect winged insect of the third brood moving about on the tree.

These facts prove conclusively that there are three distinct broods of these insects in the season, the earliest portion of the first brood about March 23d, of the second brood about July 2d, and of the third brood about October 17th, there being apparently an interval of 14 to 15 weeks between the different broods of the season. The young female insects were found crawling about through the season, and as late as the last of November. The last brood remains through the winter under the scale until the approach of warm weather in the spring, when they again appear.

While the *Aspidiotus Conchiformis* will develop but one or at most two broods per season, this new species of *Aspidiotus* will produce three broods, and each female probably 50 young. This present season of 1882 has been in the development of fruit and insects about three weeks or more later, consequently the appearance of the scale was not expected as early as last year. The first winged male scale insects of this species were discovered this year on April 25th crawling about on an English hawthorn tree. At that time no young female scale insects were to be found, but the old females under the scales were approaching maturity, and in due time the young appeared.

Foes of Scale Insects.

The natural enemies of the scale insect are the larvæ of some varieties of the *Coccinellidæ* or lady-birds.

The season of 1881 developed in great numbers an important enemy of the scale, viz: the *Chrysopa* or lace winged fly, the larvæ of which prey upon it. This is a beautiful, slender and delicate fly, bright green in color, with large golden eyes, and very long wings like lace. The eggs are very minute, white and oval in shape, and are attached by a long and slender pedicle to the underside of leaves or the fruit. The larva is about one-quarter of an inch long, slender, and tapering from the middle toward both ends. It is provided with jaws, each perforated, through which it sucks the juices of its victim.

Remedies for Scale Insects.

In 1881 Mr. J. H. M. Townsend, of the Santa Clara County Horticultural Society, kindly placed at our disposal a large number of trees infested with scale for the use of the committee in making such experiments as were desired. A series of careful experiments for the destruction of the scale pest were made and the results carefully noted. Other experiments had been under way in our own orchards for many months.

These experiments demonstrated on one hand the inefficiency of many applications, and on the other hand showed a certain means for the destruction of the scale insect. The remedies which have proven successful will destroy all the varieties of scale, as the one under treat-

ment is the most difficult of all to overcome. A portion of these experiments are numbered, and the results obtained, stated as observed at different dates up to this time, October, 1882.

No. 1. Concentrated lye of the American Lye Co., one pound, water, two gallons. February 22, 1881—Applied by spray upon two peach trees infested by scale, washed in the afternoon when the trees were dry, effect, scale killed; the tenderest wood was killed also. July 5, 1881—New wood grown over the trees four and five feet long.

No. 2. Concentrated lye, one pound, water, two gallons. March 10, 1881—Applied by spray upon two peach trees infested by scale washed in the morning when the trees were damp with dew. July 5, 1881—Scale killed; buds and twigs not injured, fruit abundant and trees most healthy.

No. 3. Concentrated lye, one and one half pounds, water, one gallon. June 23, 1881—Applied by pouring from a dipper upon two pear trees infested with scale and with numerous limbs dead. Lye as strong as to bruce bark and foliage. August 2, 1881—Scale entirely destroyed, bark being restored and new foliage appearing.

No. 4. Concentrated lye, one pound, water, one gallon. July 5, 1881—Applied by spray upon a large apple tree badly infested by scale bark and leaves burned. August 2, 1881—Scale killed, green layer of bark being rapidly restored and new leaves and blossoms appearing all over the tree. The foregoing trees have since been mostly killed by the application of a low grade of coal oil.

No. 5. Concentrated lye, one pound, water, one gallon. February, 1881—One almond tree, one Easter Beurre pear tree and two apple trees grafted, were washed by brush with this strength of lye in order to destroy the red spider and its eggs, which could not be destroyed by previous applications of lye, one pound to five gallons, and also one pound to three gallons, another and the same reason being to ascertain the effects of very strong lye upon the trees. No scale upon these trees. The application destroyed the red spider and its eggs on these trees so that it did not appear for months, but, however, later on the trees became again infested. While the strong lye will destroy a large number of the eggs of the red spider as it found that all cannot be reached. The effect upon the bark and health of these trees was wonderfully good, the bark being very smooth and having a bright green velvety appearance and totally free from all moss or other parasites.

No. 6. Concentrated lye, one pound, water, one gallon. The experiments in this number were made upon a section of orchard in a square block containing 327 fall-grafted plum trees, cut down and grafted into Petite prune, some yearling prune trees having been put in in place and washed as were the plums, of these 126 trees were washed in February, 1881, with the above strong lye, applied with a brush. Among the 267 trees were eight trees badly infested with scale. No other had any scales upon them. The infested trees were scattered about as follows, and washed as indicated:

No. 10 in first row and 4 in 11th row were washed with lye, one pound to three gallons of water. The effect was not quite sufficient to completely destroy the scale, though so impaired that they did not breed. Afterward these two trees were washed with one pound to one gallon, and thus effectually ended the scale. No. 7 in 6th row, 10 in 7th row, 8 in 12th row, 5 in 24th row, 8 in 17th row were washed in 17th row were washed with lye, one pound to one gallon of water with the effect of completely destroying every scale upon them, and not one has appeared upon any of these trees since that time. These trees have been in the finest possible condition from the time of this application.

Among the trees not washed with the strong lye two were found, in June, 1882, to have scale upon them; one of those, the top having become easily broken by wind, was dug out and burned, the other was washed soon as discovered with the whale oil soap and sulphur mixture, owing to the foliage upon this tree not very early of it could be touched. Yet, however, the scale was destroyed, so far as could be found.

No. 7. Concentrated lye 1 pound to one and one-half gallons water. Five Bartlett pear trees obtained from the nursery and planted in 1881 and scattered among a considerable number, although carefully examined at the time for scale, were found in June, 1881, to have a few scales upon them. These were all once washed with the above strength of lye, which destroyed the scale completely upon three of those trees so that none subsequently appeared. On two of them however, a live scale or two must have remained on the trunk of the tree at the surface of the ground not reached by the lye, as in September following a few young scales were observed, located close to the ground. These were again washed in the same manner. Since that washing no scale has been found upon either of these trees until this month (Oct. 15, 1882). On one of these has been found a few young scale. The tree was immediately washed with the whale oil soap and sulphur mixture and the other Bartlett pear tree, not, however, numbered with the above, was found some scales, Nov. 7, 1881. This tree, being entirely dormant, was washed with lye one pound to one gallon water, completely destroying the scale, as none can be found on it this year. Among the Yellow Egg plum trees were found a number infested with scale upon it, and washed as soon with lye one pound to one gallon water, and repeated in February. No scale were left, as none can be found at this date. Another Egg plum tree was found infested in June of this year. To this was applied, by a brush, the whale oil soap and sulphur mixture as with those lye added. No scale can now be found upon it.

The trees in experiments five, six and seven are in an orchard of 50 acres I have constantly and carefully watched all these trees, and at this date no scale can be discovered in the entire orchard. Should any hereafter appear, the treatment will be by lye one lb to one gallon water. With this success in my five years' individual practice I feel justified in repeating the statement I made at the first State Fruit Growers' Convention, that by using orchards

can be kept free from the *Aspidiotus perniciosus* by the wash one of concentrated lye as a winter wash and the whale oil soap and sulphur mixture for summer.

In the following experiments the trees were all badly infested with scale.

3 Concentrated lye, one and one-half lb; water one gallon June 23, 1881—Applied to two Clingpeel peach trees; brush used in order to save foliage, many limbs dead from effects of scale June 27—Trees burned considerably, scale killed where reached July 24—Much of the bark showing a healthier appearance July 25th—Trees still better August 24—No sign of scale; great layer of bark being restored very rapidly, the fruit quite clean, because no scales of wound brood were open it April 25, 1882—Examined the trees, and found a very healthy top, and with new bark where burned with the lye when washed to the crammer All the surface was not touched by the lye, and where not washed the scales still existed Wherever the bark was washed, owing to the time that it was done, it was cracked across Yet underneath this cracked surface was found new and healthy bark October 14 1882—There has been a good growth of new wood this season and the under bark has maintained the fresh and healthy appearance of last year.

5 Concentrated lye, one and a half lbs; water one gallon June 24, 1881—Applied on a portion of tree to ascertain the effect upon the stain of bark July 23d—The bark where washed shows much less stain; lighter in color and the green layer being restored August 24—Stain rapidly disappearing Observed.

10 Concentrated lye, one lb, water, one gallon July 5, 1881—Mixed accurately, and applied same day upon pear tree July 23d—Scale where reached entirely destroyed, bark burned by the lye, but otherwise healthy and good where it was previously sound April 25, 1882 and October 14, 1882—Observed to be nearly the same as in the preceding number, the bark under the cracked outer layer being all renewed, and with a bright, healthy, green layer free from scale, free growth of new wood during the season

11 Concentrated lye, one pound, water, one and one-half gallons. Trees washed same time as above and with about the same results as though an antehrity tree October 14 1882—The tree had here pretty well destroyed by the scale last year and shows but a little growth of new wood.

12 Concentrated lye, one lb; water two gallons. Same as above, except that the tree was still more thoroughly ruined by scale and at this date has not recovered. Just little new wood, while there is, however being healthy

13. Concentrated lye one lb, water three gallons The tree had been washed by spraying April 1, 1881, with this strength of lye, which proved to be too weak to destroy the scale July 23, 1881—Young scale insects noted the tree was then not left to itself with that wash ing April 23, 1882—Observed that the scale was abundant and just accomplishing the destruction of the tree October, 14 1882—The tree is dead to within one foot of the ground, but from the collar many new sprouts have grown

No. 14. Concentrated lye, 1 lb water, 8 gals June 23, 1881—Applied to two trees, one slightly and the other badly infested with scale This wash was used by pouring it upon the trunk of the trees and allowing it to run down and soak into the ground; the tops of the trees were not touched This experiment was made, as it had been publicly stated that this weak lye used in this manner was an effectual remedy July 2, 1881—No effect produced upon the scale where not reached by the lye. August 2, 1881—No effect other than noted above, scale only injured where touched by the lye, and second brood of young scale in scale crawling all over the top of the trees April 25, 1882—Trunk quite clean and healthy, but the top full of scale insects of the last season alive and approaching maturity October 14, 1882—Trees covered with scale, old and young, the trunk, however, where washed, appearing far more free than the upper portion, the bark where washed is healthy.

Use of Kerosene

In the following experiments with kerosene, the action of that agent was reported as at *then* appeared at the date of report but the subsequent effects which will now be stated, show how important it is to allow ample time to elapse before reporting an application upon the merits or demerits of a particular proposed remedy. The use of coal oil when the tree is full of sap is plainly shown to be unallowable These will be detailed as they appeared at the time and also as seen this season

No 15 Kerosene low grade and heavy, 100 test June 1, 1881—Applied by two pear trees, spraying, with coarse spray need and oil thrown over the entire trees June 27, 1881—Observed that the foliage had been killed and the trees considerably affected, scale killed July 2, 1881—New leaf buds coming out. July 23, 1881—New foliage all over the trees, and coming vigor throughout, new shoots six inches long, no scale to be found and the green layer of the bark healthy to all appearances August 24—Foliage increasing rapidly all over the trees and, apparently, the trees were gaining in health Thus they appeared up to August 1881 The observations of these trees on April 25, 1882 showed a very different state, the trees were dead

No 16 Kerosene, high grade, 100 test June 1, 1881—Applied by spray upon two pear trees. June 27, 1881—Observed that the foliage had not been killed, but that the scale had all been destroyed; the trees apparently uninjured. July 24—New leaf buds coming forth August 2 1881—Pear trees healthy; foliage uninjured, scale showing no signs of its presence, and the fruit showing less effects from scale on account of the wash it had removed. April 25, 1882—Trees were dead

No 17 Kerosene, high grade Diamond brand, 150 test July 27, 1881—Applied upon two pear trees with a coarse healthy spray over entire trees trees very badly infested. August 2—Effectually destroyed the scale, the trees and foliage apparently entirely healthy. No perceptible effect upon the trees, but completely drying up the scales, so that they are blown away by the wind The fruit is not affected by the kerosene, but the scale upon it is killed, and the fruit is very clean It is observed that

kerosene of 150 test evaporates rapidly, and leaves but little signs of having been applied. April 25, 1882—One tree dead, the other not dead but nearly so. October 14, 1882—Examination showed trees to be dead.

No 15 Kerosene, some brand July 27, 1881—Applied upon a pear tree by spray atomizer, which produced a very fine mist only. Aug 1st '81.—The same effects produced as in No 17, scale appeared to be entirely destroyed, no apparent effect upon tree or foliage. April 25, 1882—Tree not dead, but with many scales upon it. October 14, 1882—Old wood dead, but new wood from near the ground.

No 19 Gasoline July 27, 1881—Applied upon a pear tree by heavy sprayer, spray thoroughly over the tree and foliage. August 2, 1881—Not effectual in destroying the scale, but volatile assay of the insects killed, but a large portion unaffected, no apparent effect upon the tree or foliage at that time, no thin tree the young male scales just hatched out were found crawling about. April 25, 1882—A few live scales found, all others killed by the season but made a vigorous growth of new wood quite clean from scale. The foregoing applications of kerosene and gasoline were made in full strength

Whale Oil Soap and Sulphur

No 21 Whale oil soap and sulphur mixed 1 lb, water 1 gal. June 23, 1881—Applied by spray upon pear tree, covering foliage and fruit thoroughly. July 23d—Scale killed; tree gaining in health; green layer or bark being restored, fruit greatly improved in appearance August 2, 1881—Tree still improving, also fruit. April 28 1882—Tree very healthy and appears clean from scale, green layer of bark being daily restored, also fruit. The tree that were nearly killed by the scale are forming new bark rapidly, the tree has a very fine top of new growth October 14 1882—The tree has grown very thriftily through the season and the wood is all very healthy, some scale are found upon the tree, however. These trees are in an orchard badly infested, and it is to be expected that the insects will return. This wash is an effectual summer wash, and where there is any scale present should be used in the strength here given, as a wash of one-half the strength has proven ineffectual.

Soft Soap and Sulphur

No 22 Soft soap, one pound sulphur, one pound; kerosene, one pound, water, three gal lons July 5, 1881—Applied upon two trees by spray, covering trees, foliage and fruit thoroughly. July 24, 1881—Rumored quite effectual at the time, many scale destroyed, but not all, trees not affected by the wash, fruit improved in appearance Subsequent observations, however, showed that but little was accomplished in destroying the scale October 14, 1882—The trees shows an abundance of live scale in all stages of growth The wash was tried with good effect in another orchard, June 1, 1881, on a Feltenberg prune tree, cleaning it from scale, which up to this time, have not returned.

No 23 Soft soap, one pound, sulphur, 1 pound; water, three gallons.

No 24 Soft soap, 1 pound, water, 3 gallons; The two washes named above were applied June 23, 1881, and with no effect, neither has it shown any result this season.

Whale Oil Mixture

No 25 Whale oil, one pint; kerosene, one pint, borax, one ounce, water, one gallon. June 23, 1881—Applied by spray to a pear tree at the different dates in 1881, the effect has been observed it has been apparent that the oil is decidedly injurious to the tree, applied in this manner or at this time, it is therefore not recommended. Applied to another tree in one fifth the strength above given, it has no effect upon either scale or tree April 25, 1882—The tree first treated is nearly dead, but, however, having the top cut off, new wood is coming along, scale appears to be destroyed. October 14 1882—The old wood is dead, the scaly growth of new wood springing out from the lower portion of the tree shows some scale.

Carbolic Acid

No 26 Carbolic acid, three ozs , water, two gal lons. June 23, 1881—Applied by spray upon a pear tree badly infested with scale July 27, 1881—Failed entirely The tree afforded a constant succession of insects in all stages of development, both male and female From it some of our most interesting studies were made we regret it as it appeared at each visit on that date (June 27, 1881), we found the male insect under the developed pupa case, with wing pads but wings not yet out July 24—Found plenty of winged males of the second brood flying and crawling about. July 23d—Tree was covered with young female scale insects of the second brood crawling and with a few of them just located and commencing to be covered with their scales. June 25th—A few of the winged male still found, bark scraped clean on this date was in two days covered with young scale and with delight formation of scale over them. Aug 23—Tree entirely covered with young male on this date, two or three winged males were found. April 25, 1882—Tree almost dead from effects of scale, top dead and resurrected and a few feeble shoots coming forth October 14, 1882—Shoots have grown from the trunk of the tree to some extent, but the whole having been so seriously infested the tree is pronounced worthless

The entire orchard in which these trees are situated, other than the ones experimented on, from 5 to 8 were washed this past winter with a very low grade of coal oil called 'tree wash' the result is not satisfactory, the swarm bells me(October 14, 1882) that he is satisfied that the oil has accidently injured his trees.

San Jose, October 25 1882.

Experiments with Steam.

It was at one time thought that steam might be effectually applied for the extermination of insect pests upon trees. In the summer of 1881 a test of this agent was made in an orchard near San Jose A large tent was made to hang upon a frame, which could be run on either side of,

and overhanging the tree the tent then being dropped, the tree was entirely enclosed in no air tight bag, into which the steam and other ingredients were forced, and left to act upon the tree and insects as long as was thought necessary.

Horticultural Commissioner D. C. Vestal and myself carefully noted the experiments made and placed the results upon record. These experiments are also numbered for convenience in describing.

No. 1. Sept. 8 1881. An apple tree infested with scale insect, woolly aphis and other pests was covered by the tent, under which was hung upon the tree cloths saturated with bisulphide carbon, one half pound. It was thus left for three fourths of an hour, and then the tent was removed. Result, apparently of no effect. The woolly aphis was not injured, but found crawling about. The red spider was found crawling about also a small caterpillar was observed unharmed. The scale insects were not affected in any way so far as could be observed. Sept. 12, 1881.—Examination made on this date showed the same effect had been made by the application upon any of the insects mentioned as infesting this tree. Mr. J. H. Wheeler, the owner of the bisulphide carbon, thought that the agent had not been properly brought into contact with the insects and for that reason failed to destroy them.

No. 2. A pear tree was treated with steam forced under the tent, covering the tree. The temperature was raised to 165° and maintained for 10 minutes. Observations immediately afterwards showed that the foliage of the tree and the young wood of the tree was destroyed. Everything was cooked thoroughly. September 12th.—The tree and the scale were both killed.

No. 3. An apple tree was treated in the same manner, with steam at 140°, for three minutes, and afterwards with sulphur fumes (caused by putting two handfuls of sulphur upon live coals) for five minutes. The result showed that the tree had not appear quite as much injured as that in the 2d, the spreading tree as first showed, but as soon as September 12th the effect was the same. The scale was killed, and also the entire tree, except the oldest part of the trunk.

No. 4. Apple tree steamed for five minutes at 140°; dried for five minutes, and then fumed with sulphur for five minutes. Result the same as the preceding.

No. 5. Apple tree moderately covered with scale and woolly aphis. Steam applied with which had previously been mixed three gallons of kerosene, pumped into the boiler of a steaming engine. The application was made at 140° and maintained for four minutes. September 12th.—No effect was perceptible upon the tree, except that the foliage was considered injured. The scale insects were not killed to any extent. The woolly aphis was found alive and unimpaired.

No. 6. Steam and coal oil applied four minutes at 140. September 12.—Tree pretty nearly killed. Only the oldest wood alive—all new wood and buds killed.

No. 7. Steam and coal oil for six minutes at 140°. Same as for six minutes at 150. No. 9, same for 12 minutes at 140 to 120. This tree was steamed four minutes, and then, after an interval of ten minutes, was steamed two minutes more. September 13th.—The result upon these trees was the same. The trees were all destroyed excepting the trunk and oldest wood.

From these experiments it will be seen that steam cannot be applied in such manner and at a temperature sufficiently high to destroy the insects without, at the same time, destroying the tree.

During the season of 1881 strong efforts were made to ascertain the use of

Various Patented Mixtures,

Which were claimed to have great merit in destroying the scale insect. One of these was to be used by simply spreading it on the trunk of the tree, which application it was stated would, through the poisoning of the sap, kill the insects. This, as well as others of a like nature, were given careful consideration and tested and resulted in entire failure.

Another method, which was persistently forced upon the public, was that of boring into the trunk of the tree to the centre, and filling the auger hole with the so called cure. A careful investigation of many trees so treated was made by Mr. Mathew Cooke, Mr. D. C. Vestal and myself, for the purpose of determining the actual effects, if any of the treatment. Oct. 17, 81, we singled out several of these pests, who had allowed his name to be used in recommending this exterminator, and first examined two pear trees bored and the holes filled with the preparation. These trees were found to be covered with live scale insects in all stages of development, and showing no signs of injury. The young female insects were found crawling about the trunk in great numbers. The wood, the season's growth, was covered with scale. An apple tree, the trunk and large limbs of which had been washed the previous winter with strong lye, showed that the scale which completely covered it when the lye was applied were entirely destroyed where the wash had reached, but on the smaller wood which had not been reached by the lye the scale was found alive. This tree had also been bored and treated with the application referred to, and which had no effect whatever. On the trunk of this tree, where the lye had been applied, the green layer of bark was found replacing the old, which had nearly been destroyed by the scale. At another place we examined a pear tree which had been bored and treated with this preparation. This tree was in no manner whatever affected by this so-called remedy, but was completely covered with scale insects in every stage. We found the young females crawling about, and on this tree was found the male scale in the first pupa stage of development for the third winged brood, not also on this tree was discovered the perfect winged male of the third brood. In no case has the slightest good resulted from these secret and patented preparations. We have treated this subject thus fully because, to our knowledge, prominent and careful horticulturists have been induced to purchase these things at an exhorbitant charge.

The treatment of trees by

Crude Petroleum

And the different products has been thoroughly

tried in this country, and, it must be confessed, with conflicting results. Some still claim that coal oil is efficacious, and if properly used, safe, but the advocates of this practice are very few now, although at one time, orchardists were pretty evenly divided in the use of coal oil on the one hand, and that of concentrated lye on the other. The treatment of orchards by crude petroleum was commenced in 1872–80, but was not extensively tried until 1880 81. Many orchards were then drenched with crude petroleum, greatly to the regret of the users. The following season the advocates of coal oil abandoned the use of the crude and applied it carefully, and produced a little better. This is called tree wash, and was about this past season very extensively.

This whole subject may be treated as with one agent. Many orchards have been visited where this treatment has been adopted and where the result has been disastrous. One prominent orchardist used the tree wash upon about 200 out of all varieties of trees and has lost almost the entire number. A great part of the dead trees have the season been dug out. Another used this wash upon 60 fine cherry trees, 10 years old, killing them all. Another adjoining the last-named washed with the same and killed 125 choice cherry trees. Another had used it upon a portion of his orchard, thus killing all his trees except apples and pears, which partially rallied and put forth a stubby new growth. These results can be substantiated by many other orchardists who have met with a greater or less degree of loss from the use of oil, and almost every person who has seen in favor of using coal oil has abandoned the accursed work. Lewis Leonard has an orchard where it is the intention to apply it again. This one, from some cause, appears not to have suffered from its use, and a visit to this orchard on the 14th of October showed a very large and fine crop of apples being gathered which were almost free from scale. This orchard, belonging to father and son the Messrs. L., has been washed with the following mixture. In 1879 80 some trees were treated with kerosene of 150 test. In 1880 81 crude petroleum was applied to the trees of the entire orchard. These were principally apple trees, numbering about 600 although there were trees of every other variety. In 1881 82 the tree wash was applied to the same trees and in the same manner. As stated, this orchard is almost free from scale and the trees appear healthy. The Messrs. L. attribute their success with coal oil to the following means of procedure. It is applied in the middle of the winter, or before the sap begins to flow. It is applied in the finest possible spray, and is allowed to touch any part but once. The work is done when there is a mild, and when there is no moisture upon the tree. All this evidence leads to the conclusion that the products of petroleum are most hazardous to the life of the tree, and while one or two may not experience the loss of their orchards, the hundreds of others would destroy their trees. Therefore, with all this added experience before me, I most emphatically condemn the use of petroleum or refined coal oil of any grade for the purpose of an insecticide.

The effect of coal oil upon trees of all varieties of stone fruits is particularly disastrous, being less upon apples and pears. I now again refer to the use of

Concentrated Lye,

Which, as before once in this report, has been of such great service, and which I consider to be the specific, or at least so far as we now know, the best means of destroying the scale insects of deciduous trees. In the case under consideration where the *aspidiotus perniciosus* is involved no other application will do the work as well, as a winter remedy which can be used when the trees are dormant. The lye is quite caustic little if any harm, but on the other hand in most cases positive benefit to the tree is, where used with care and in the proper strength, an effectual remedy. The only other remedy which can be recommended is the Whale Oil Soap and Sulphur Mixture (scalbe moth wash), which is applicable as a summer wash particularly.

A few prominent examples of the employment of lye on a large scale will be given to show its usefulness and success. Great results had been obtained by the application of concentrated lye, but the donuts strength to which it should be used was only determined in the season of 1881, since recently the most comprehensive were made for applying it on a large scale in entire orchards. In the early part of this paper reference was made to the losses of one orchardist, Mr. T, as an instance to illustrate the condition of many orchards in this vicinity. This orchard was visited a few days since (Oct. 14th) and the most gratifying news of its health and appearance of the trees, which had by careful treatment been made to survive the devastating effects of the scale.

As was before stated, many of the trees destroyed had been dug out. These were particularly apple trees. Some, however, had survived, though badly injured. These being heavily cut back had put forth a new growth, which at this year most satisfactory. The pear and plum trees especially have shown the good effects of treatment, and are now vigorous and so the way to great fruitfulness. Owing to the late spare and all small wood of the pears being killed by the scale two years ago, there could be but little fruit this year, but from the fine thrifty growth on these from a large crop of fine fruit is promised for the coming season. The plum trees, of which there is a large number, have made a fine recovery from the effects of the scale, and yielded this year a valuable crop of fruit, obtaining of French prunes at the sale of eight tons to the acre of fresh fruit. The total yield of fruit this season exceeded in value that of the last by a large percentage. The fruit has been of fine quality and very clean. At least 90 per cent. of the total yield has been entirely free from scale, and of the 10 per cent. remaining none of that was as bad as the fruit of the entire crop of last season. The coming season he expects to have a very large crop of fine and perfectly clean fruit. Mr. T. has used both oil and concentrated lye on the trees, not however together, but separately. He says he shall not use oil again as he is satisfied that it injures his trees. Lye has given him his first results. It has been used in the strength of about 1lb to 2½ gals. water, but in the strength

it has required a longer time and a larger number of applications to destroy the scale. Although some scale is still to be found there, the orchard is nearly cleaned of the pest. It is intended to use lye and the caustic soda the coming winter.

Another extensive orchard near to the above belonging to Mr. R. has been thoroughly treated by concentrated lye. The orchard of 30 acres in which are 5,000 trees, has been one of the worst infested by scale. Last winter the entire orchard was drenched by lye, applied by fine spray in the strength of one lb. to one gallon water, and one lb. three oz. to one gallon water, some few trees with even stronger solution. This application was made from December, 1897 to February, 1898. Again visited April 20th last showed the scale to be pretty thoroughly destroyed. The trees at this date were in a most vigorous and healthy condition with beautiful green foliage and bearing full of fruit, well set in all varieties, far enough advanced at the time. Other trees more in full bloom at that time. On October 15th I again visited this orchard to ascertain the success of results, and found it has borne out the estimate made of it in April last. The growth of wood has been very fine and healthy. The crop of fruit has been good this season, and has been almost entirely clean. The cherries were entirely so. The plums and prunes, of which there was an immense crop on about 1,200 trees, were also wholly free from scale. Also the pears, peach and apples were most of them clear of scale, though a few were slightly infested. Some scale remains on this orchard but as little compared to last season, that although the quantity of fruit was about the same, the quality was far superior, and therefore in value far greater. A portion of the peach trees, which still showed some few scattering scale, were washed in September with a solution of lye showing 4° by the hycometer, in which was mixed sulphur as much as could be forced through a coarse nozzle, and whale oil soap in small quantity. This has apparently cleared away the few scale that were pressed. It is intended to wash with lye the coming winter in the same manner as last, wherever it may be required.

Another prominent example of the use of lye is that upon the orchard of Mr O——, in the celebrated fruit growing locality known as the "Willows," San Jose. This orchard is chiefly devoted to the culture of the cherry and is one of the best known in the State for that product. There are also a few hundred French prune trees. All of these trees, both cherry and prunes, range in age up to 15 years. Two years ago the *aspidiotus pernicuosus* appeared on the white cherries, nearly destroying a number of trees. In the winter of 1896-1897 the trees were washed with concentrated lye, 1 lb to 5 gallons of water. It resulted in some good, but did not kill many insects. In January, 1898, with the exception of one tree mentioned further along, the entire orchard was washed with concentrated lye, 1 lb to 1 gallon of water. All varieties of trees subject to scale were washed twice—the applications being made two weeks apart. The method employed was by heavy spray contained upon the tree from 15 to 20 minutes for each tree. The fluid dropped from the tree upon a table arranged under it, and then seeping the material from paths. October 15th I examined this orchard. On the cherry trees all of the scale has been destroyed upon almost the whole of the trees washed. On a few trees, however, there are at this time a few scale to be found, bred from some not reached by the wash. The effect upon the cherry trees was not injurious, except that a few fruit spurs were killed. The trees this year bore a very fine crop of fruit, wholly free from scale. Not a single specimen of scale could be found upon any of the fruit, as a careful inspection was made of it for that purpose. The effect upon the prune trees was a little greater, killing a larger number of fruit spurs. This is partly attributed to the state of the atmosphere, as it was warm and dry when these were washed. Not a scale insect can now be found upon any of these trees, although very large trees and very badly infested with scale. Mr O intends to wash his trees the coming winter with lye in the strength of one pound to two gallons of water, using also the table as before. The saving caused by this was at least two thirds of the material.

The Drain Table

This table is made of sheet zinc fixed upon a frame in halves, which are placed against the trunk of the tree either side. Also a forming a circular basin 14 ft in diameter, and requiring but one minute for transfer from one tree to another.

An Insulated Tree Attacked.

The tree mentioned as not being washed was a Cleveland Bigarreau cherry, standing in the orchard yards from any tree infected, being surrounded by the Black Tartarian trees, which are never infested. This tree last winter at the time of washing the orchard had no scale upon it. Now, however (October 14th), I find this tree covered with scale already matured as well as many young crawling about upon it. This is an interesting observation, as it shows the rapidity with which a tree may become covered with this pest, and also that the scale will migrate out and colonise itself upon trees in its taste. In this orchard no cherry of the black varieties has been infested. The Black Tartarian, the Black Bigarreau, Knights Early Black, the Black Eagle, and the Early Purple Guigne, are some of them troubled, and neither has the Black of Orleans shown any insects. The white varieties of cherries are among the worst infested trees we have.

Caustic Soda.

Some orchards have also been washed with the English caustic soda. One steward in one that he had used it upon his entire orchard of all varieties of trees, mostly however, Newtown pippin apples, in the strength of 10 lb by the hycometer. It was not used in this case for the purpose of destroying scale, for the orchard was free from it, excepting some of the *Aspidiotus conchyformis*, which it destroyed, the object was to clean the trees of moss, and also to kill the red spider. The trees were cleaned, and a large proportion of the red spider eggs killed, but not all by any means. This caustic soda is obtained in large drums of 600 lbs., and is somewhat cheaper than the concentrated lye, which last may cause it more frequent use hereafter. Many other insects might be

olied to show the efficacy of lye as fumigant, but sufficient facts are stated.

How the insects are spread.

Attention must be called to the means of spreading this serious pest, the *aspidiotus perniciosus*. The system of "return boxes," and packages of any character, is known to be pernicious and a fruitful source of the spread of all kinds of noxious insects, which, either as insects, eggs or larvæ may be fastened to them and taken into the orchard, to be developed in due time and then to spread devastation to every thing attacked. Indeed, to me, as shearsmen in the return box that I will not permit one to be brought into the orchard or on the premises. I prefer to pay the cost of new boxes, and give them with the fruit sold. As the female insect has no wings, she can, of course, only be spread about by becoming attached to something by which she is carried to different localities, and by crawling about during the short period after hatching before becoming fixed for life.

Birds will carry them most frequently about an orchard, and it is thought that one source of danger little regarded, is the carrying about on one's clothing by brushing against infested trees.

If boxes or packages are returned, they should be disinfected as soon as received by dipping in boiling water, to which is added not less than one pound of potash to 25 gallons of the water used.

The nursery trees sent over the State have been the means of spreading the scale extensively and while nurserymen are anxious to make sale of their trees they must take every precaution to see that their patrons do not suffer by neglect to first destroy the scale, which may be done by dipping the trees in a solution of concentrated lye of 1 lb to 2 gallons of water. I am glad to say that most nurserymen are desirous to do all in their power to destroy the scale.

Among other means of preventing the spread of scale, thorough and constant cultivation of an orchard should be kept up, and one prominent duty in the way of eradicating the scale I believe to be the practice in pruning of growing other small crops in the orchard between the trees.

It cannot be too strongly impressed upon the mind of every owner of an orchard that he must personally watch his orchard and exercise such constant supervision that no infested tree shall escape observation, and, when found, the proper remedy at once be applied. In the orchard referred to where chance trees have been found infested, no other course would have saved me from the ever whelming spread of the scale.

The experiments of 1881 and the subsequent use of lye in instances mentioned indicate the remedy. That should always be used when the trees is dormant, and when the foliage has not appeared from the trees. In our climate that time is the winter, and at any time before the trees put forth their buds.

Applying the Lye.

The strength of lye should be one lb to one gallon water where trees are infested with scale. Where it is only desired to cleanse the tree from moss one lb to three or four gallons of water is sufficient. The best method of applying the concentrated lye is by dissolving in boiling water, and throwing it upon the trees with a force pump through 40 or 50 ft. of one-half inch rubber hose, to which is attached a nozzle, having for its opening a simple straight slit, very narrow in width, and one sixteenth to one eighth of an inch long. The best spray tip yet devised is that used at San Jose called the Merget Spray Nozzle. The pumps most used for this purpose are the Gould pump and the Merget pump. The latter is made at San Jose, and is cheaper than the Gould pump. Great care should be taken to cover the tree entirely with the solution of lye, as upon its thorough application depends its success.

One of the greatest difficulties in the use of strong materials is from the spray falling upon the person of the operator and burning and injuring the skin. In order to overcome this obstacle, I have devised a simple "extension nozzle" of slight cost which is very light and which may be made of any length desired, say from four to 15 ft., or even longer. By the use of this extension it is perfectly easy to reach and spray any orchard tree without danger and discomfort. The cost of materials and apparatus may be given as follows:

The Gould pump at about $16 without extension. The Merget pump $12. The suction hose and the long hose will cost according to quality used, from 5 cents to 25 cents per foot.

The Merget spray tip, if purchased alone, $1.50. If bought with pump, the pump and spray $13. The brother extension with globe valve about ft long $2.75. All extension length over seven ft. 25 cents per foot. The concentrated lye, of the American Lye Co. in one-lb cans by the case of 48 lbs., $3.50 per case. Anglich caustic soda in 60 pound drums, $3.5 to $35 per drum. The white oil soap and sulphur mixture called the "Cedlic Moth Wash" is manufactured in San Francisco and the price can be obtained by inquiring of Messrs Allyne & White.

In conclusion I will give the analysis made by Prof. Hilgard, of the State University, of a sample can of American Lye Co. concentrated lye. The can sent I took from a lot I had been using and is supposed to be a fair sample of the manufacture. The analysis is as follows:

Caustic potash	52.8
Caustic soda and carbonate of soda	10.7
	100.0

With this I submit my report, expressing my firm conviction that ere long we shall be freed from the ravages of one of the most dreaded pests known to horticulturists.